mation and subsequent deposition of sulfuric acid over northeastern North America." In a leap that is not explained in the summary, NAPAP then concludes that "although reducing the emissions of sulfur dioxide in any season is likely to result in the reduction of dry and wet deposition of sulfur compounds, the magnitude and extent of the reduction cannot yet be evaluated."

According to Tom Bridges, "on a regional scale, over time, if you reduce sulfur dioxide emissions, you get a corresponding change in sulfate concentration in surface waters. You may not find this one-to-one relationship in January, but field experiments show that it is an approximate linear relation through time." Moreover, he says, both NAPAP and Canadian officials agreed to that conclusion in the February 1987 "Joint Report to the Bilateral Advisory and Consultative Group."

At NAPAP, Paul Ringold, the associate director of research, agrees that "over large areas and long periods of time, what goes up comes down. But how relevant those time and space scales are is a different matter. If it comes down in the Atlantic and not in the Adirondacks, it probably doesn't matter."

According to NAPAP, many of the major questions—such as source-receptor relationships, the cause of high-elevation forest decline, and the effect of episodic pulses on aquatic life—will not be resolved until NAPAP's final, 1990 assessment. And until that time, any policy recommendations or the implementation of sulfur dioxide controls would be premature.

The implication is clearly that nothing needs to be done before then anyway, given the minimal effects observed to date. NAPAP describes emerging technologies, such as integrated gasification combined cycle (IGCC), that appear to be so efficient that "their implementation may proceed steadily based on economics alone." IGCC can achieve "99+%" removal of sulfur dioxide from high- and low-sulfur coal, NAPAP asserts, though others say this has yet to be demonstrated. If these new technologies are adopted, NAPAP says, by 2030 utility emissions would be reduced to 3 million metric tons a year, down from the current level of about 22 million metric tons.

Many members of Congress do not plan to wait for these technologies to be adopted or, for that matter, for NAPAP to resolve the outstanding questions in 1990. In mid-September the Senate Committee on Environment and Public Works is scheduled to mark up an acid rain bill that calls for about a 14-million-ton reduction in sulfur emissions. NAPAP's timing for the release of its interim assessment that same week is probably not coincidental. ■ **LESLIE ROBERTS**

Choppin Takes Reins at Howard Hughes

The new president of the Howard Hughes Medical Institute has plans to support individuals at schools without big HHMI units and to offer stipends to select graduate students

THE presidency of the Howard Hughes Medical Institute (HHMI) has been called the most influential biomedical research job in the world. With his recent appointment as Hughes' new president, Purnell W. Choppin, a virologist and physician of modest demeanor, has assumed leadership of a $5-billion philanthropy with the resources and clout to shape medical research in America for decades. He succeeds Donald S. Fredrickson who recently was forced to resign as a result of an administrative scandal.

As Hughes vice president and chief scientific officer for the past 2 years, Choppin has already made his mark by leading the institute into the area of structural biology. In a recent interview with *Science* in his Bethesda, Maryland, office a couple of miles from the National Institutes of Health,* Choppin talked about other plans he has for HHMI—plans that include the support of younger scientists, including graduate students, as well as programs at institutions that do not have medical schools of their own.

In terms of the science it supports, Hughes, which was founded in 1953 by the reclusive billionaire aviator, has always limited itself to carefully chosen disciplines. Human genetics has long been its mainstay, along with cell biology and regulation, and immunology. Then neuroscience was added to the list, and now structural biology, with its emphasis on the use of advanced x-ray crystallography, magnetic resonance imaging, and computer graphics as tools of the trade. Six new structural biology units with state-of-the-art equipment have been established at Baylor, Columbia, Harvard, the University of California at San Francisco, the University of Texas at Dallas, and Yale.

Choppin's own research has included work on the structure of viruses, nearly all of it done at Rockefeller University, which he joined in 1957 when it was still the Rockefeller Institute. When he left Rockefeller in 1985 to join Hughes, he was senior physician, vice president for academic programs, and dean of graduate studies. Choppin, 58, is a graduate of Louisiana State University and its School of Medicine. He is a member of the National Academy of Sciences and of the Institute of Medicine, on whose governing council he serves.

Choppin takes over at Hughes at a crucial moment in the institute's history. As trustee chairman George W. Thorn has pointed out, the fiscal year that began on 1 September "can be viewed as the first year of the institute's maturity." All of its legacy of financial and legal burdens are now behind it. For years, HHMI was in a state of limbo while Howard Hughes' heirs argued over his will. When that was finally settled and new court-appointed trustees were named, HHMI was able to find out how much it was really worth by selling its only asset—the Hughes Aircraft Company—to General Motors for more than $5 billion (*Science*, 21 June 1985, p. 1414). And, perhaps most important, last year the institute settled a decades-long dispute with the Internal Revenue Service (*Science*, 13 March, p. 1318) with a resultant agreement to spend a minimum of 3.5% of its assets annually as a "medical research organization (MRO)," and to spend $500 million during the next 10 years in the more traditional foundation mode.†

The institute's operating structure is central to the way it does business on university campuses and is of particular concern because of speculation that as the Hughes presence grows, so will its power to shape, and possibly distort, the biomedical research enterprise.

Under the law, a medical research organization must spend 3.5% of its assets in the *actual conduct* of research. Thus, Hughes' scholars are not grantees, but employees. The institute actually owns laboratories on university campuses. Instead of paying an indirect cost rate to university administration, it pays directly for items such as heat and light. A Hughes unit at Harvard or Yale, for instance, is simultaneously part of the university (Hughes people must have

*HHMI, 6701 Rockledge Drive, Bethesda, MD, 20817.

†Details about the new HHMI grants program will be released early next month.

faculty appointments) and apart from it.

According to terms of its IRS settlement, Hughes will continue to operate primarily as an MRO for the next 10 years, which carries a requirement that it spend 3.5% of its assets annually, but does not preclude expenditures in excess of that amount. Although some universities would like to see Hughes become a regular grant-giving foundation, obligated to spend 5% of assets per year, HHMI trustees are said to prefer the current arrangement as one that does not put them in a position of having to dispose of more money than they can prudently spend; nor does it limit them to 3.5%. In 1986, HHMI spent about $240 million, including construction; in 1987 the figure was $178 million; in 1988 disbursements are likely to hit $200 million.

By tradition, Hughes investigators are anointed by the institute's elite medical advisory board of ten, which is chaired by Lloyd (Holly) Smith of UCSF. Although people do write in, there is in fact no formal way to apply for a Hughes job. Hughes scholars have always been among the stars of academic medicine, enjoying the security of Hughes funding and the luxury of not having to write NIH grant proposals.

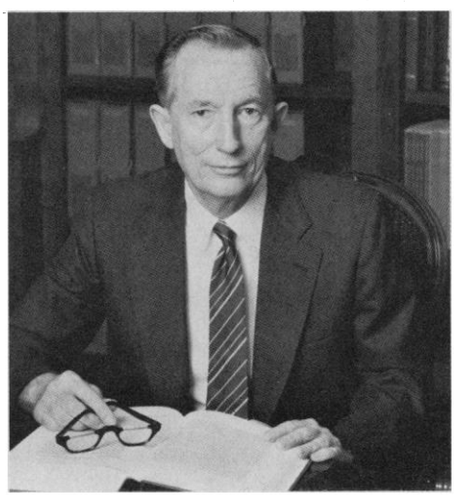
Hughes investigators have also always been a distinct minority. And a handful of stars have not perturbed the system. But with Hughes now launched on a program of substantial growth, the sheer numbers of lucky Hughes researchers will grow. Already, medical school deans report instances of using a Hughes appointment as a lure to a leading researcher from a competitive institution, or as a lure to keep someone from leaving.

Whereas Hughes researchers once numbered fewer than 100, the ranks are swelling. Just a year ago, Hughes employed 120 research scientists. Since June 1986, it has recruited 58 more. Large Hughes units, some backed with sums in the $50-million to $100-million range, are in place on 27 campuses. Choppin estimates that by 1991, Hughes will employ 250 to 300 investigators. A large number of them, he told *Science*, will be graduate students and young researchers at the assistant professor rank.

Spotting bright young people is high on Choppin's list of goals, and is something his colleagues say he is very good at. "Purnell knows all the important people and his job here, which he's done well, has been identifying bright young people," says one Rockefeller colleague. Thus, in the future, Hughes will not only anoint scientific stars, it will help to create them. The danger, for which no one seems to have a solution, is that biomedical research will become to some extent a world in which there are the Hughes people and all the others.

The fact that Hughes intends to support graduate students with stipends twice that paid by NIH is something people will watch. According to Choppin, HHMI expects to support about 60 graduate students at first, and will pay them a stipend of $12,000 for living expenses. "What we'll be doing is analogous to the National Science Foundation's program, rather than NIH's," he says. In addition to the student's stipend, Hughes will pay the institution a fixed sum for tuition that may or may not cover the full cost, as tuition varies among graduate schools. NIH, by contrast, pays full tuition whatever it is.

"We're trying to prevent Hughes from being seen as a foreign object on campus," says Choppin, who acknowledges that a certain prestige is attached to Hughes' people. With respect to graduate students, what he and other Hughes officials hope is that by modeling itself on NSF, Hughes will help push NIH stipends up.



Purnell Choppin: *"We're not emphasizing new units. There may be campuses where we support only one or two people."*

Taking Hughes in another new direction, Choppin expects that no major new HHMI units will be built at universities. "Laboratories of 13,000- to 30,000-square feet have been the norm," he notes. Many new or expanded units have been funded according to Fredrickson's precept that Hughes should concentrate on places with a "critical mass" of top-flight scientists (*Science*, 7 June 1985, p. 1178). Choppin sees Hughes tapping individual talent and supporting people wherever they are. "We're not emphasizing new units," he says. "There may be campuses where we support only one to two people."

Choppin also anticipates the expansion of Hughes to institutions that do not have their own medical schools. Under terms negotiated as part of the IRS settlement, Hughes will be allowed to operate as an MRO at places where there is an "intellectual conjunction" between the research and medicine. (In the past, all HHMI-supported research had to be done at a medical school.)

Thus, Hughes is now supporting two researchers at the University of California at Berkeley, with links to the UCSF medical campus across the bay. Hughes supports a mariculture program at Woods Hole where snails are grown for neuroscience research. Plans have been laid for construction of a $3.2-million beam line on the synchrotron at Brookhaven. "Our argument to the IRS was that this augments our medical research in structural biology, and that the line had to be built where the synchrotron was," Choppin told *Science*. When it's complete, it will be available to all researchers, not just Hughes investigators. Negotiations are also under way for Hughes-supported work at the Massachusetts Institute of Technology, where a good number of faculty also have appointments at the Massachusetts General Hospital.

And last but not least, Choppin wants to extend HHMI's support clinical research, an area that some critics say has fallen into disfavor as the institute adopted a decidedly molecular focus under Fredrickson.

Choppin is widely regarded by his colleagues as a first-rate basic scientist, and a man of integrity and sound judgment who will bring a needed sense of order to Hughes after several turbulent months that saw Fredrickson's ouster as HHMI president.

Fredrickson, who advocated the support of high-powered, elite corps of scientists at the country's best medical schools, was forced to resign following allegations of fiscal mismanagement that included charges that his wife mishandled Hughes funds when purchasing furniture for the institute's headquarters (*Science*, 12 June, p.1417). Lawyers retained by HHMI trustees have still been unable to account for all of the money in a $200,000 account Mrs. Fredrickson apparently established in her unauthorized role as Hughes decorator. Fredrickson has consistently denied any wrongdoing by either himself or his wife, who said in an interview with the *New York Times*, "I'm a very noble, first class woman, and anybody who says different is going to burn in hell."

The anticipated sense of calm and order that Choppin is expected to bring to HHMI was very much in his favor as the institute's trustees conducted their search for a new president. As one trustee said of Choppin's low-key manner, "It is just fine with us." ■

BARBARA J. CULLITON